The Flotation Methods of Industrial Wastewater Treatment

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ABSTRACT

The article considers flotation methods for industrial wastewater treatment. As a result of experiments in wastewater treatment, various design schemes, applications and flotation methods have been developed. The froth flotation method was used to remove some insoluble and partially reduce the concentration of some solutes, and the froth separation method was used to remove the dissolved substances.

Keywords: environmental protection, rational use of natural resources, ecology, sanitary norms and requirements.

Introduction

During the years of independence, the Republic of Uzbekistan has developed and implemented important legal, organizational and socio-economic measures to ensure environmental security. More than 15 laws directly regulate the relations in the field of environmental protection and rational use of natural resources, mechanisms and conditions of use of certain types of natural resources, as well as state ecological expertise, organization of separate categories of protected areas and their separate use regimes. More than 30 normative and legal documents defining installation procedures and other issues have been adopted and are in force [1-3].

The adopted documents allowed to reduce the level of pollution in the environment, develop a system of protected areas, to involve international organizations in solving national environmental problems. At the same time, an analysis of the current system of public administration and control in the field of environmental protection has revealed several shortcomings and problems. In particular: the lack of a single state body to coordinate and control the activities of individuals and legal entities, specially authorized government agencies, organizations and enterprises in the field of waste management; Due to the lack of a legal basis for the State Committee for Nature Protection's subordination to the Cabinet of Ministers, it is impossible to fully cooperate with interagency agencies in the field of environmental protection and to solve practical problems in this area; Insufficient and ineffectiveness of administrative penalties provided by law for violation of environmental, sanitary norms and requirements in the field of environmental protection and rational use of nature; The powers of the State Committee for Nature Protection in the field of waste management were limited to the control of industrial waste [4-7]. The current organizational structure of the committee and the unity of the state do not allow it to carry out the tasks assigned to it in a quality and complete manner.

Materials and methods

Flotation is the process of molecular adhesion of particles of floatable material, two phases, usually gas (usually air) and liquid, to the surface of the boundary layer, which is based on excess free energy as well as surface wetting events. For the separation of flotation devices, effluents, oils, petroleum products, oils, hydroxides, SFMs and other organic substances, solid particles with a hydraulic size of 0.01 mm/s, polymers, fibrous materials, as well as mixtures are applied. The method of flotation treatment of wastewater is the formation of "particle-foam" complexes, the emergence of these complexes and the removal of the resulting foam layer from the surface of the recycled liquid. It is observed only as a result of the particles in the effluent sticking to the surface of the gas bubble, the particles do not get wet in the liquid or are poorly moistened [7-9].

The wetting ability of a liquid depends on its polarity, and as the polarity increases, the wetting ability of the liquid decreases. The magnitude of the surface tension at the boundary between the liquid phase and the liquid phase, as well as the polarity difference between the liquid and solid phases, is the appearance of the liquid from the outside. When the surface tension of the water is 60 ... 65 mn/m, the flotation process is efficient. The size, quantity, and even distribution of air bubbles in wastewater are important in the flotation process [10-13]. The optimal size of air bubbles is 15 ... 30 microns, and the maximum size is 100 ... 200 microns. Various reagents are added to the water to form bubble-particle aggregates: aggregates, foaming agents, regulators that increase the hydrophobicity of particle surfaces, dispersion and stability of gas bubbles. Through experiments on wastewater treatment, various design schemes, applications and methods of flotation have been developed.

The foam flotation method is used to remove some insoluble substances and to partially reduce the concentrations of some solutes, and the foam separation method is used to remove solutes. Significant differences in flotation methods are due to the fact that the liquid is saturated with air bubbles of a certain size. Based on the same principle, the following methods of flotation treatment of industrial wastewater can be distinguished:

1) air flotation from solution (vacuum, tension and airlift flotation devices);
2) flotation with mechanical dispersion of air (impeller, stress-free and pneumatic flotation devices);
3) air flotation through porous materials;
4) electroflotation;
5) biological and chemical flotation.

Flotation devices can consist of one or two compartments (chambers). In single-chamber devices, in the same compartment, the liquid is saturated with air bubbles at the same time, and the flotating contaminants rise to the surface of the water. In the two-chamber devices, consisting of receiving and settling compartments, in the first compartment the formation of air bubbles and "bubble-particle" aggregates occurs, and in the second compartment the sludge rises and the liquid is clarified [14-17].

Figure 1. Flotation by removing air from the solution

Flotation of air from the solution is used to treat industrial wastewater, which consists of very fine particles of contaminants, which allows obtaining the smallest air bubbles. Its essence is to form a highly saturated solution of air in the effluent (Fig.1.). The air released from such a solution forms microbubbles, which flotate the contaminants in the wastewater. The amount of air that must be separated from the saturated solution and provide the required flotation efficiency is typically 1 ... 5% of the wastewater is recycled.

The advantage of vacuum flotation is that the formation of gas bubbles, their adhesion to the particles of contaminants, the formation of "bubble-particle" aggregates occur in a quiet environment, and the probability of their destruction is minimal. At the same time, the energy required to saturate the liquid with air is kept to a minimum. In addition, there are disadvantages of the vacuum flotation process, such as the need to build hermetically sealed tanks, the difficulty of operating vacuum flotation devices, as well as their limited range (the concentration of contaminants in wastewater should not exceed 250 mg/l) and others [17-19]. The effluent entering the flotation is saturated with air in the aeration chamber for 1-2 minutes, from where it enters the deaerator to remove undissolved air. Then, under the action of dehydration (0.02 ..... 0.03 MPa), the effluent enters the flotation chamber, where the air dissolved at atmospheric pressure is released in the form of microbubbles and particles of contaminants are released into the foam layer.

The duration of wastewater in the flotation chamber is 20 minutes, and the voltage per 1 surface area is about 200 m^3/day. The collected foam is sent to the foam collector by means of rotating scrapers. In order to dispose of the treated wastewater, the flotation chamber and the receiving tank are provided with the required water level markings or pumps are installed (Fig.2).

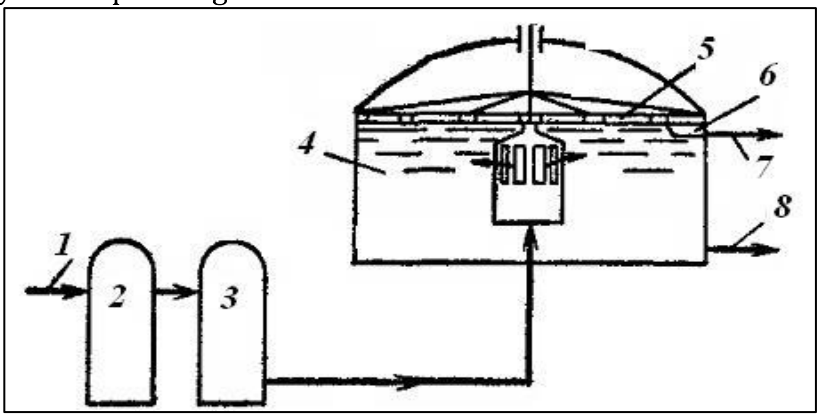
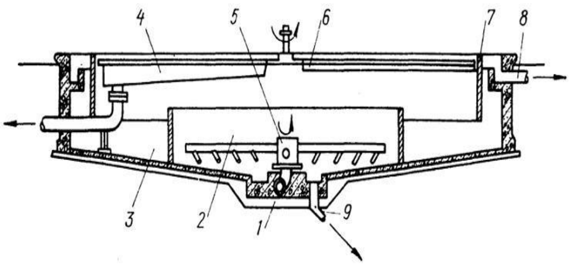


Figure 2. Scheme of separation of air from solutions in the vacuum process of flotation.

1 - sewage supply; 2 - aerator; 3 - deaerator; 4 - flotation chamber; 5 - foam combing mechanism; 6 - foam collector; 7,8 - Proper removal of foam and wastewater.

Strict flotation is widely used in wastewater treatment. This, in turn, allows controlling the degree of saturation of the wastewater at the appropriate efficiency required when the initial contamination concentration of wastewater is 4 ... 5 g/l and above. The strainer flotation device includes a collector (receiver) tank for collecting wastewater, pumps, ejectors or compressors, a strainer tank (saturator) for saturating water with air, a flotation chamber and equipment for collecting foam and disposing of contaminants. Preliminary coagulation of water is planned to increase the efficiency of treatment. Sewage is pumped to the saturator. In the saturator at a pressure of 0.3 ..... 0.5 MPa, the dissolution of air in the amount of 3-5% of the volume of purified water is observed.

This air-saturated water is transferred to a flotation chamber operating at atmospheric pressure. There, the release of dissolved air is observed and the flotation process is carried out. Thus, as the pressure decreases, gas bubbles form as the solubility of the air in the water decreases. During this time, the release of gas from the water takes place directly in the particles. The resulting mass is sent to the foam collector using combing mechanisms.



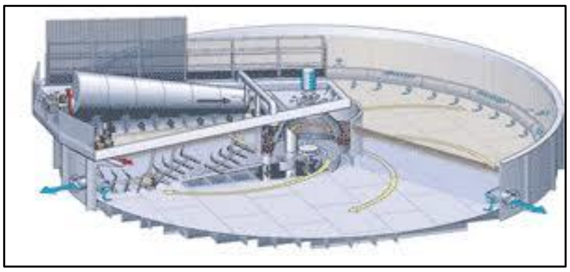


Figure 3. Radial flotator

1 - supply of water for purification; 2 - receiving department; 3 - flotation chamber; 4 - discharge sludge receiver; 5 - rotating water distributor; 6 foam absorbing mechanism; 7 - ring barrier; 8 - removal of treated water; 9 - Sediment removal.

The depth of the flotation and settling zones is at least 1.5 m, and the time of water availability is set at least 5 and 15 min, respectively. Air-saturated effluent enters the flotation from below through a circulating water distributor. Air bubbles released from the water, along with particles of contaminants, rise to the surface. The foam is sucked into the tray by a rotating mechanism and lost. The treated water is removed from the bottom of the unit and poured into a drain ring along vertical channels. The capacity of one flotator should not exceed 1000. Airlift flotation. Energy consumption in airlift flotation is 2 ... 4 times less than in rapid flotation, but the design of the device, the height markings between the feed tank and aerator in the wastewater, as well as between the aerator and the flotation chamber, a certain o. 'requires a change (the difference in designations is 20..35 m), which limits the need to use this method to some extent.

Flotation of air by mechanical dispersion (Impeller flotation) When an air stream is displaced in water, it undergoes a rapid oscillating motion. As a result, the airflow is broken down into individual bubbles. In impeller flotation devices, rapid mixing of wastewater results in a large number of small turbulent flows in the device. This allows you to get bubbles of a certain size [19-21].

It is advisable to use impeller flotation devices for the treatment of high concentrations (2 ... 3 g/l) of insoluble contaminants and sewage containing oil, petroleum products and oils. It is widely used in impeller flotation, raw material enrichment and wastewater treatment, from easily foaming substances.

The disadvantage of this flotation method is that it does not allow the use of coagulants, as the coagulant coagulation is disrupted during the turbulent mixing of water. The effluent flows from the water intake pocket to the impellers where the air is sucked through the tube.

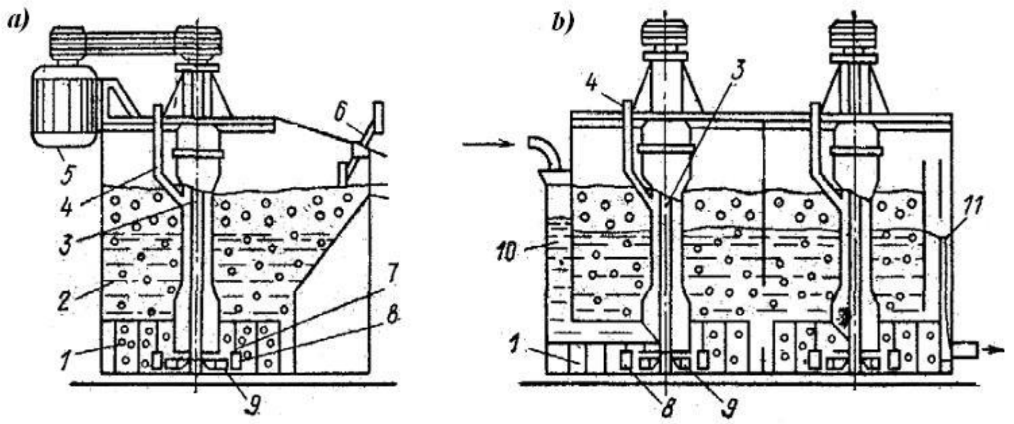


Figure 4. Two-chamber direct flow flotation device:
a - cross-section; b - longitudinal section; 1 fenders; 2 - flotation chamber; 3 - impeller vali; 4 - air duct; 5 - electric motor; 6 - foam remover; 7 - hole in the stator for internal circulation of water; 8 - stator; 9 - impeller; 10.11 - Private receiver and output pocket.

Above the impeller is a disk-shaped stator with a hole for internal water circulation. The water and air mixed in the impeller are discharged through the stator. The grilles around the stator help the air to disperse finely in the water. The foam, which is made up of air bubbles, is expelled using a foam conveyor. The water flows from the first chamber to the second chamber, which has a similar design, where additional wastewater treatment takes place. Air flotation through porous material is characterized by the simplicity of equipment and relatively low energy consumption. The air is transferred to the flotation chamber through small porous filter plates, tubes and fittings placed under the chamber. The size of the holes should be 4 ... 20 μm, air pressure 0.1 ... 0.2 MPa, flotation time 20 ... 30 minutes, and airflow is determined experimentally. The working level of the treated wastewater is 1.5 ... 2 m before flotation. The main disadvantages of this method are the growth and contamination of the pores, as well as the difficulty in selecting small porous materials that allow the release of small bubbles close to the size of air bubbles.

The biological and chemical flotation method is used to condense residues in wastewater. Wastewater flotation produces a variety of foams, usually with a film structure. There is a certain amount of water in the bottom layer of the foam, and its strength and movement depend on the amount and nature of the materials being flotated. The process of compacting the floating foam intensifies in the first 2 hours. Then it slows down and stops after 4 hours. The process of compacting and breaking the foam layer is carried out by spraying or heating. In many cases, the disposal of foam condensate is not economically feasible.

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